Tab V – Materials

DAM SAFETY ASSURANCE PROGRAM
EVALUATION REPORT AND
ENVIRONMENTAL IMPACT STATEMENT

APPENDIX C – TAB V
CONCRETE MATERIALS AND
STONE SLOPE PROTECTION

DOVER DAM, OH
TUSCARAWAS RIVER

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1.0 Introduction

The existing facility began operation in 1937, consisting of a concrete gravity dam featuring 23 monoliths. The dam is hydrologically deficient, and is structurally unstable against sliding at pool elevations well below PMF. Therefore, a number of revisions have been proposed, as part of the Dam Safety Assurance program, to bring the dam up to modern standards. Several of these revisions require cast-in-place concrete features to be constructed. The height of the dam must be increased from elevation 916 to elevation 923 with a reinforced pre-cast concrete parapet wall. The parapet wall panels will be placed on the upstream edge of the existing dam. Other planned modifications include construction of erosion cutoff wall (drilled shafts), I-wall extensions and a gate closure for the walls. The total estimated quantity of concrete required for these modifications will be provided in the DDR Phase of the project, but is currently estimated to be approximately 3,656 cubic yards.

2.0 Concrete Materials

A complete investigation of all concrete materials including availability, estimated costs, and quality will be performed during the DDR phase of this project. Materials to be investigated include concrete aggregates, cement and pozzolan. To date, only preliminary investigations have been performed, which included review of existing test results from sources in the project area.

2.1 Features and Placements

Raising the existing non-overflow sections with a concrete parapet wall constructed on the existing dam would allow the dam to safely pass 100% of the PMF. I-wall sections are also necessary to continue the parapet walls to their termination at high ground. Both parapet walls would be constructed on the upstream side of their respective non-overflow portions of the existing dam. The parapet wall and I-wall combination on the left abutment of the dam, averaging 7-feet high and 1.5-feet wide, would be approximately 240 linear ft. and 140 linear ft. respectively. The proposed parapet wall on the right abutment of the dam would be approximately 130 linear feet. This parapet wall would then connect with a 170 linear ft. I-wall, also averaging 7-feet high and 1.5-feet wide, which would connect with a 25 ft. wide by 4 ft high gate closure across Ohio State Route 800. The estimated quantity of cast in place concrete required for the I -wall is 265 cubic yards. The swing gate closure design will include two abutments, a sill, a storage pedestal, a flood wall transition and a structural steel gate. The abutments will be reinforced concrete members and include a reinforced concrete spread footing for stability. There will be a reinforced concrete sill between the abutments. These structures will require approximately 220 cubic yards of concrete.

All pre-cast concrete for the parapet wall should contain materials meeting the requirements to be set forth in the DDR. If an aggregate source is selected that has not been evaluated during the DDR phase, a complete testing program and service record

evaluation will be required prior to acceptance. The estimated quantity of precast concrete required for the parapet panels is 151 cubic yards. The mixture for the parapet wall should have a specified strength of 7000 psi at 28 days and air content between 5 and 7 percent. The maximum water to cement ratio will be 0.45. The concrete will contain an air-entraining admixture and may contain a water-reducing admixture when its formulation and use are approved. Mixture proportioning will be the responsibility of the manufacturer.

Ninety-one drilled shaft caissons will be drilled in the downstream end of the dam to serve as erosion control during a high water event. The shafts will be 6-feet diameter and average 34-feet deep. Every other shaft will be reinforced. The estimated quantity of tremie concrete required for drilled shafts is 3,240 cubic yards. The tremie concrete mixture will consist of a ¾" nominal maximum size aggregate.

2.2 Concrete Exposure Conditions

2.2.1 Climate

The climate of Tuscarawas County is continental, with pronounced seasonal changes marked by wide annual and day-to-day temperature ranges. Mean maximum temperatures in January are around 35°F and around 85°F during July, with occasional days above 90°F. Precipitation averages 37-40 in per year and is fairly evenly distributed across the basin. Annual snowfall ranges from 30 inches in the south to 40-50 inches in the north, and the average frost-free growing season through most of the region is 150-160 days.

The concrete placed for the scour protection and portions of the I- wall will be subject to intermittent flowing water, therefore extra precautions in this regard were not taken since velocities at these structures will normally not exceed 40 ft/sec (as noted in EM 1110-2-2000). Sulfate exposure will be determined with water quality testing for the Tuscarawas River and the surrounding soil during the DDR phase. If sulfate content in either the water or soil is excessive, protective measures will be taken with the requirement of cement replacement with Class F fly ash and Type II low alkali cement. The project is located in the severe weathering zone indicated by EM 1110-2-2000, Figure 4-1, therefore, freeze-thaw action is of high concern and concrete aggregate quality requirements will be set accordingly.

2.3 Mixing and Curing Water

It is assumed that the concrete produced for this project will be provided by a ready mix provider and therefore, the source of water for that plant should be tested. All project mixing and/or curing of concrete should be tested in accordance with and meet the requirements of ASTM C 1602. The optional chemical requirements set forth in Table 2 of ASTM C 1602 should be invoked as well.

The water can not be used if highly sediment-laden, or if the water chemistry changes significantly as determined based upon regular testing. Therefore, if the contractor

wishes to use river water for mixing, a proposal to ensure consistent quality of the mixing and curing water will be required to be submitted for approval by the government. The Contractor is responsible for providing surfaces free of stain after curing as well.

The Water Quality Section of the Huntington District had not collected water quality data in the project area since 1977. Since the amount of coal mining activity along the Tuscarawas River in the Dover Dam area has increased significantly since the samples were analyzed, it may be necessary to collect up-to-date water quality data. EM 1110-2-2000, Section 2-4 references the PCA Manual on Design and Control of Concrete Mixtures (1988) for additional information on chemical limits for mixing water. This water quality testing program should include measurements of sulfates, iron, chlorides, alkalis, dissolved and suspended solids and pH.

2.4 Concrete Aggregates

Generally fine aggregate must consist of natural sand or manufactured limestone aggregate and coarse aggregates must consist of manufactured limestone or dolomite; however, there are few sources of coarse limestone aggregate in the project area that are capable of meeting the quality requirements. Since the original Dover Dam structures contain natural gravel and have performed well for over sixty-five years, natural gravel may be considered for the DDR phase. In conducting preliminary aggregate investigations, various lists of potential sources have been reviewed. These include COE TM 6-370; mineral producer surveys for Ohio prepared by the state geologic survey and ODNR mineral producer surveys; and Huntington District aggregate source files. Several potential sources were determined to be within an economically feasible distance of the project. A list of aggregate sources tested and acceptance limits that were developed for the Piedmont DSA project (another dam within the Muskingum Basin) is provided below.

	Olen Corporation Frederickstown, OH	Midvale Sand & Gravel New Philadelphia, OH	Stockers Sand & Gravel Gnadenhutten, OH Plant 2	Acceptance Limits
Classification	Quartz, Siltstone, Limestone	Quartz/Siltstone	Quartz/ Siltstone	
Specific Gravity ASTM C 127/128	2.605	2.617	2.608	2.60 min.
Absorption ASTM C 127/128	2.13%	1.25%	1.3%	1.5 % max.
Organic Impurities ASTM C 40	0	3	2	Not Darker than No. 3
% Lighter than Sp. Gr. 2.0 ASTM C 123	0	0	0	1
% Flat and Elongated ASTM D 4791 (CRD-C 119/120)	0.08%	0.33%	0%	L:W of 3:1 or 5% max.*
MgSO4 Soundness ASTM C 88	11.92%	7.18%	10.5%	12%
Alkali Silica Reactivity ASTM C 1260	0.323%	0.335%	0.373%	0.1% 14 day limit (if > 0.2%- Long Term Testing is Required)
Alkali Silica Reactivity ASTM C 1293	Not Available	Not Available	0.065%	0.04% at 3 months
Durability Factor Freeze Thaw ASTM C 666-97 (Method A)	47	83	40	75 Min.
Petrographic Exam. (% chert) ASTM C 295	1.5%Chert 3.0% Shale	2.8%	3.2%	5% max.

Table 1. Fine Aggregate Test Results

*The amount of flat or elongated particles, or both, at a 3:1 L /W or W/T ratio is limited to 5% in any size group of fine aggregates.

	National Lime & Stone Bucyrus, OH	Midvale Sand & Gravel Sidwell, OH	Stockers Sand & Gravel Gnadenhutten, OH Plant 2	Acceptance Limits
Classification	Dolomite/ Limestone	Sandstone/Siltstone/ Limestone	Sandstone/Siltstone	
Specific Gravity ASTM C 127 & ASTM C 128	2.626	2.591	2.567	2.6 min.
Absorption ASTM C 127 & ASTM C 128	2.29%	1.85%	2.18%	1.0% max.
L.A. Abrasion ASTM C 131 & ASTM C 535	31.6%	25.78%	28.44%	30% Loss max.
% Lighter than Sp. Gr. 2.4 ASTM C 123	0.17%	11.67%	10.6%	1% max.
% Flat and Elongated ASTM D 4791 (CRD-C 119/120)	0.58%	2.37%	2.42%	L:W of 3:1 or 5% max.*
MgSO4 Soundness ASTM C 88	6.79%	8.04%	7.25%	6% max
Alkali Silica Reactivity ASTM C 1260	0.048%	0.339%	0.373%	0.1% 14 day limit (if greater than 0.2%- Long Term Testing is Required)
Durability Factor Freeze/Thaw ASTM C 666-97 (Method A)	53	24	23	75 min.
Petrographic Exam. (% chert) ASTM C 295	0.2%	9.8%	9%	1.0% max. 0.5%- finished surface

Table 2. Coarse Aggregate Test Results

*The amount of flat or elongated particles, or both, at a 3:1 L /W or W/T ratio is limited to 5% in any size group of coarse aggregates.

These tests were performed during a testing program in 2001. For the fine aggregate, only Midvale was capable of meeting the freeze/thaw durability requirement. Olen Corporation and Stockers were well below the acceptable durability factor for freeze/thaw testing and therefore will not be included in the DDR investigation. None of

the coarse aggregate sources tested for the Piedmont project were capable of meeting the quality requirements, however, since most of the ready-mix sources in the project area utilize National Lime and Stone for coarse aggregate, re-testing is justified; therefore, during the DDR Phase for this project, the sand from Midvale Sand and Gravel and the coarse aggregate from National Lime and Stone in Bucyrus should be re-tested and service record structures should be examined for durability. See Exhibit 1 to see these quarry reports from the Piedmont DSA materials investigation. In addition to these two quarries, the sources below will be tested for the above properties during the DDR Phase of this project:

Source	**Location**	**Classification**	**Size(s)**	**Distance to Dover**
416 Sand & Gravel	New Philadelphia	River Sand	Fine	4 miles
National Lime & Stone	Carey, Ohio	Dolomitic Limestone	Fine & Coarse	120 miles
Oster Sand and Gravel	Bolivar, Ohio	Natural Sand & Gravel	Fine & Coarse	10 miles
Shady Bend Stone	Newcomerstown, Ohio	Natural Sand & Gravel	Fine	23 miles
Kimble Clay and Limestone	Dover, Ohio	Limestone	Coarse	5 miles
Daron Coal Company	Cadiz, Ohio	Limestone	Coarse	10 miles
National Lime & Stone	Carey, Ohio	Limestone	Coarse	11 miles
Hanson Aggregates	Massillon, Ohio	Limestone	Coarse	14 miles
Phoenix Stone Co.	Magnolia, Ohio	Limestone	Coarse	16 miles

Table 3. Aggregate Sources Proposed for Testing During DDR Phase

2.4.1 Concrete Aggregate Quality

2.4.1.1 Petrographic Examination

Petrographic analyses should be performed on the aggregates in conformance with ASTM C 295. Petrographic examination is performed for two purposes: (1) lithologic and mineralogic identification and classification and (2) determination of composition, physical, and chemical characteristics. Through petrographic analysis, an estimation of the resistance of the aggregate to freezing damage may be made. Particles that may produce popouts or disintegration as well as potentially reactive minerals, may also be identified. Through petrographic analysis a determination can be made to the susceptibility of an aggregate to react with the alkalis of cement.

2.4.1.2 Specific Gravity

Specific Gravity should be measured for each sample as defined in ASTM C 127 and ASTM C 128. Aggregates with low specific gravity are usually suspected of being potentially unsound and thus, not suited for use in the exposed portions of hydraulic structures in moderate-to-severe exposures. All the sources for aggregate should meet the minimum 2.6 specific gravity.

2.4.1.3 Absorption

Absorption should be measured for each sample in conformance with ASTM C 127 and ASTM C 128. Absorption data are generally believed to be somewhat indicative of the probable influence of aggregates on the durability of concrete exposed to freezing and thawing when subject to critical saturation. In concrete production, a high absorption rate could cause problems maintaining air entrainment and would increase the amount of water required, which could result in slump loss.

2.4.1.4 Organic Impurities

The test for presence of organic impurities, ASTM C 40, is used to determine if objectionable amounts of organic impurities may be present in the fine aggregates.

2.4.1.5 Soft Constituents, Clay Lumps and Friable Particles

The percentage of clay lumps and friable particles should be measured in each fine aggregate sample in conformance with ASTM C 142. The presence of soft, friable or otherwise deleterious material may cause degradation of the aggregate, producing excess fines that must be removed by screening or washing. If extensive screening and washing are required, some sound material may be lost, increasing costs.

2.4.1.6 Particle Shape

Excessive amounts of flat or elongated particles, or both, in aggregates will severely affect the water demand and finishability of concrete. The fine and coarse aggregate samples should be tested in conformance with ASTM D 4791 and CRD-C-120.

2.4.1.7 Soundness

Results of the soundness tests are directly related to the freeze/thaw resistance of concrete. All the sources should be tested under the guidelines of ASTM C 666, method A. Magnesium Sulfate Soundness tests have also performed in the past in accordance with ASTM C 88. Although the sulfate soundness test is no longer recommended by EM 1110-2-2000 due to its poor correlation with the actual service performance, test results are still provided from the Piedmont project. A limit of 6 % loss is normally required for aggregates in MgSO testing. This acceptance criterion should be omitted in the specifications and designers should rely more on results of the ASTM C 666 test for soundness. Generally a minimum durability factor from soundness testing is set at 75, however, the aggregates in the project area generally have much lower durability. Service record information may have to be relied on more heavily than laboratory test results.

2.4.1.8 Abrasion

The resistance to abrasion should be measured for each coarse aggregate sample in conformance with the standard test for resistance to degradation of coarse aggregate by abrasion and impact in the LA Abrasion machine (ASTM C 131 and ASTM C 535). Generally a material having a high abrasion loss will tend to break down during handling and excessive grinding may occur with such materials during mixing. If a material has a high durability factor, as derived from ASTM C 666, the abrasion loss should not be considered as significant, however, the aggregates in the project area generally have low factors of durability, and therefore abrasion resistance may have greater bearing.

2.4.1.9 Alkali Aggregate Reactivity

Alkali aggregate reactions fall into three categories: 1) Alkali reaction with amorphous silica, 2) Alkali reaction with silicates in polyphase siliceous aggregates (shale, granite, sandstone) and 3) Alkali reaction with dolomitic carbonates. The first two categories can be classified as alkali-silica reaction (ASR) and the third category can be classified as alkali-carbonate reaction (ACR). The results of such reactions can include expansion (ASR) and cracking (ASR and ACR) of concrete, exudation of expansive gel (ASR), weakening of bonds between cement paste and aggregate (ACR) and overall deterioration of structures (ASR and ACR). The potential of the aggregate to react adversely with the alkalis in the cement was determined using several ASTM test methods. All fine and coarse aggregates should be tested with ASTM C 1260 "Potential Alkali Reactivity of Aggregates". In some cases, if an aggregate is determined to be potentially deleterious, long term AAR testing may be performed in conformance with ASTM C 1105, ASTM C 1293 and ASTM C 586 to determine if the alkali reactions are due to silica or carbonate. During the Piedmont DSA aggregate testing, the coarse aggregate for Stockers Sand and Gravel showed expansion during testing in accordance with ASTM C 1260 and was rested in accordance with ASTM C 1293 to determine if the expansion was due to reactive silicas.

When testing a material for ASR, in accordance with ASTM C 1260, an expansion of less than 0.1 percent in the concrete mortar bar, means the material is considered to be innocuous in regard to ASR. When an expansion between 0.1 and 0.2 percent is observed, the material is considered to be innocuous and deleterious. To mitigate the expansion of less than 0.2 percent, the concrete must contain Type II low alkali cement and have at least 20 percent fly ash replacement. If more than 0.2 percent expansion in mortar bars is observed, the material is considered to be deleterious. If time permits, a source designated as deleterious, may be retested in accordance with ASTM C 1293 using Type II low alkali cement and up to thirty percent class F fly ash replacement. If test results show an expansion of less than 0.1 percent, the source may be considered acceptable; however, this may not be feasible since the ASTM C 1293 is a one year test.

2.4.1.10 Service Performance

Each aggregate source should be investigated for service performance. When searching for service records, generally the structures exposed for longer periods are most reliable; however the performance of a structure cannot be directly correlated to the aggregate due to differing cementitious materials, admixtures, exposures, etc. Since the aggregates in

the project area generally perform poorly during laboratory testing, the service performance will be thoroughly investigated to determine durability.

2.4.2 Nominal Maximum Size Aggregate (NMSA)

In general, it is most economical to use the largest aggregate compatible with placing conditions. Aggregates of 1 ½-inch and ¾-inch will be the NMSA for cast-in-place mixes. Since this project will likely not entail concrete quantities to require the use of an on-site batch plant, ready-mix concrete will be utilized. Commonly the greatest nominal maximum size aggregate available from ready mix plants is 1 ½-inch.

2.5 Concrete Plant Investigation:

It is anticipated that the quantity of concrete for this project will not justify the need for an on-site batch plant. Several sources of ready-mix concrete have been identified in a reasonable hauling distance to supply the Dover project. These sources are listed below:

Producer	Location	Distance (Time)	Distance (Miles)
Twin Cities Concrete	Dover, Ohio	5 minutes	3 miles
Stockers Concrete	Gnadenhutten, Ohio	15 minutes	15 miles
24/7 Concrete	New Philadelphia, Ohio	10 minutes	7 miles
Pleasant Valley Ready Mix	Sugarcreek, Ohio	15 minutes	12 miles

Table 4. Local suppliers of ready mixed concrete

The sources of fine and coarse concrete aggregate for these ready-mix plants will be tested during the DDR Phase of this project. See Exhibits 2 through 5 for details of sources for these ready mix companies.

2.5.1 Ready-Mix Requirements

Sources of ready mixed concrete should meet the requirements set forth in ASTM C 94. In accordance with UFGS 03300A, paragraph 3.8, mixed concrete shall be discharged within 1 ½ hours or before the mixer drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. When the concrete temperature exceeds 85° F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the transporting unit. The sources listed above are within a distance from the project that would meet these requirements.

3.0 Stone Slope Protection

Rock for stone slope protection (SSP) must be durable and of a suitable quality to ensure permanence in the structure and climate in which it is to be used. The stone will be subjected to the usual seasonal changes of weather and temperature. The stone protection that will be located at or near the water surface will be subjected to freezing water and sub-freezing temperatures over the winter months. The stone must be free from cracks,

seams and other defects that would tend to increase unduly its deterioration from natural causes. Specifications should state the freeze-thaw and wet-dry test criteria stated in the DDR.
The stone should have a top size of 36 inches and should be uniformly graded to a 6-inch minimum size.

3.1 Sources of Stone Slope Protection

Material suitable for stone slope protection can be obtained from commercial limestone sources within 50 miles of the project site. Several limestone quarries are active within this area. The closest quarry known to be in current production is located approximately 8 miles from the project site in Dover, Ohio. This quarry is owned by Kimble Clay and Limestone, a subsidiary of Penn-Ohio Coal Company. The quarry is capable of producing 36-inch stone from the Vanport and Pittsburg Seams. Most commercial quarries in the region do not produce stone of this size on a regular basis, although this material is typically available as a set-aside product from aggregate production, however, blasting methods could be altered to enhance production of the stone slope protection material. Material for stone slope protection should be limestone or dolomite and could be transported by truck from a quarry to the project site.
The following limestone producers were contacted and are capable of producing 36-inch stone. These sources will be tested for the quality requirements listed below in paragraph 3.3.

Source	Location	Classification	Distance to Project
Kimble Clay and Limestone	Dover, Ohio	Limestone	5 Miles
Daron Coal Company	Cadiz, Ohio	Limestone	10 Miles
National Lime & Stone	Carey, Ohio	Limestone	11 miles
Hanson Aggregates	Massillon, Ohio	Limestone	14 miles
Phoenix Stone Co.	Magnolia, Ohio	Limestone	16 miles

Table 5. Potential Sources of Stone Slope Protection

3.2 Quantities of Stone Slope Protection

An estimated 4,740 cubic yards of 24-36 inch stone will be placed to supplement existing stone along the downstream edge of the stilling basin to provide additional erosion protection. These placements include 1440 cubic yards downstream of the spillway, 1940 cubic yards along the downstream bank of the left abutment, and 1360 cubic yards along the downstream bank of the right abutment.

3.3 Quality of Stone Slope Protection

Material for use as stone slope protection will have to meet the quality requirements for unit weight, adsorption, absorption, freeze/thaw and wet/dry. If the material is not able to

meet this criterion, further service record investigations will be performed to determine stone quality.
For previous projects in the area the following quality requirements were set for stone slope protection. These limits will be adjusted to ensure the best quality stone is acquired for this project.

Quality Requirement	**Test Method**	**Acceptance Limit**
Unit Weight	ASTM	160 pcf
Adsorption	ASTM C 127	2%
Absorption	ASTM C 127	2%
Freeze/Thaw	ASTM D 5312	2%
Wet/Dry	ASTM D 5313	3%
Petrographic Analysis	ASTM C 295	Limestone/dolomite free of weak planes
Gradation		36-inch top size uniformly graded

Table 6. Quality Requirements for Stone Slope Protection

List of Exhibits

Exhibit 1: Quarry Report for National Lime & Stone, Bucyrus, Ohio
Exhibit 2: Twin Cities Concrete Co.
Exhibit 3: Stockers Concrete Co.
Exhibit 4: 24/7 Concrete
Exhibit 5: Pleasant Valley Ready Mix

References

AMERICAN CONCRETE INSTUTUTE, MANUAL OF CONCRETE PRACTICE (ACI)

ACI 211.1-95	Standard Practice for Selecting Proportions for Normal Heavy-Weight and Mass Concrete
ACI 233R-95	Ground Granulated Blast-Furnace Slag as a Cementitious Constituent in Concrete
ACI 318R-02	Building Code Requirements for Structural Plain Concrete
ACI 304.4R-95	Placing Concrete with Belt Conveyors

AMERICAN SOCIETY OF TESTING AND MATERIALS (ASTM)

ASTM C 33	Standard Specification for Concrete Aggregate
ASTM C 40	Standard Test Method for Organic Impurities in Fine Aggregate for Concrete
ASTM C 87	Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C 88	Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
ASTM C 94M	Standard Specification for Ready Mixed Concrete (2000)
ASTM C 117	Standard Test Method for Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	Standard Test Method for Lightweight Pieces in Aggregate
ASTM C 127	Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	Standard Test Method for Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Abrasion Machine
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	Standard Specifications for Portland Cement
ASTM C 186	Standard Test Method for Heat of Hydration for Hydraulic Cement
ASTM C 295	Standard Guide for Petrographic Examination of Aggregates for Concrete

ASTM C 311	Standard Test Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 441	Standard Test Method for Effectiveness of Mineral Admixtures or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 535	Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 586	Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks for Concrete Aggregates (Rock Cylinder Method)
ASTM C 595	Standard Specification for Blended Hydraulic Cements
ASTM C 618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 845	Standard Specification for Expansive Hydraulic Cements
ASTM C 1105	Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction (R 2002)
ASTM C 1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)
ASTM D 1293	Standard Test Method for pH of Water
ASTM C 1602	Standard Test Method for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D 4791	Standard Method of Test for Flat and Elongated Particles in Coarse Aggregate
ASTM D 5312	Standard Test Method for Durability of Rock for Erosion Control Under Freezing and Thawing Conditions
ASTM D 5313	Standard Test Method for Durability of Rock for Erosion Control Under Wetting and Drying Conditions

CORPS OF ENGINEERS (COE)

COE CRD C 38	Method of Test for Temperature Rise in Concrete
COE CRD C 55	Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD C 120	Test Method for Flat and Elongated Particles in Fine Aggregate
COE TM 6-370	Test Data-Concrete Aggregates and Riprap Stone in Continental United States and Alaska

UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS)

UFGS 03 3100A	Unified Facilities Guide Specifications for Cast-in-place structural Concrete (April 2006)

USACE ENGINEER MANUAL (EM)

EM 1110-2-2000	**Standard Practice for Concrete for Civil Works Structures (1 February 1994)**

USACE ENGINEER REGULATION (ER)

ER 1110-2-1150	Engineering and Design for Civil Works Projects, Appendix D - Content and Format of Design Documentation Report

US Army Corps
of Engineers
Huntington District

EXHIBIT 1
QUARRY INVESTIGATION
Piedmont Lake Spillway Deficiency
National Lime and Stone
Bucyrus, Ohio

PURPOSE OF INVESTIGATION

The National Lime and Stone quarry, located in Bucyrus, Ohio, was investigated as a possible source of coarse aggregate for the Piedmont Lake Spillway Deficiency Project in Piedmont, Ohio. The quarry was investigated by Huntington District geologist Joan St. Clair on 20 July 2001. Aggregate samples were taken on a later date by Bob Stadler, certified sampler from Bowser Morner.

LOCATION

The National Lime and Stone, Bucyrus quarry is off of the Bucyrus Exit on Rt. 30W. The quarry is located ~7 miles from Rt. 30 on Bethel Road. Bucyrus is located approximately 130 miles from the Piedmont project area. Although this distance seems excessive, the materials would be hauled by rail to Midvale, Ohio. This quarry has been in operation since the 1920's under the name of National Lime and Stone.

GEOLOGY

The entire quarry operation is in the Honaker Formation, which is probably Silurian in age. The top of the quarry is at the contact of the Honaker and Nolichucky Formations. Bucyrus, Ohio is located within the ground moraine of ice-laid deposits from the Wisconsin Ice Age. The deposits are characterized by a smooth surface of till ("hardpan"), which forms relatively flat land. The Honaker Seam is characteristically medium to light gray, very fine crystalline and massively bedded dolomite. This dolomite consists of limestone layers 1 to 2 inches thick separated by thin layers of argillaceous limestone; including lenses of gray shale locally. Much of this limestone is ribbon limestone. The dolomite is both thick and thin bedded.

The quarry strikes approximately N45W with an average dip of the beds of 22 to 23 degrees. The strata are planar with joint spacing approximately 2 feet. See photograph 4.

Additional information regarding the lithology of the quarry is available in the petrographic analyses of the coarse aggregate.

The quarry consists of one highwall and one bench. The highwall is approximately 40 feet high. The exposed material consists of planar bedding with 2 to 3 foot bedding plane breaks and blocky, angular fracture. See photos?

No set aside material was available for viewing at the time of the inspection, although two ledges were exposed for observation. The material exposed since 1997 was light to medium gray with some iron stained rocks and appeared slightly dolomitic with zones of fossils (brachiopods,). The other observable ledge had been exposed since at least 1950. Minimal weathering was observed. No shale partings, lenses or seams were noted in the bedrock. Minor amounts of chert were observed, although according to ODOT freeze/thaw tests, the material contains 0% chert. Brose indicated that there is an intermittent clay seam ~ ¼ inch thick located in the bedrock.

PRODUCTION

Quarry contains two pits, one of which is no longer active. Current production is from approximately 575 feet of the Honaker Formation, with 1 bench operation. Blasting takes place about once every three to four weeks usually using a 12 X 12 pattern. ANFO (Ammonium Nitrate and Fuel Oil) is used for blasting. Material from blasts is processed through a jaw crusher. The quarry is capable of producing approximately 800 tons per hour or 2 million tons per year.
Material from the quarry is shipped either on CSX rail (75%) or truck (25%). In order for transport of materials by rail to be economically feasible, the destination should be greater than 50 miles from the quarry. Most materials are railed to a stockyard in Midvale, Ohio, which is approximately 29 miles from the Piedmont Lake Project.

According to the quarry manager, reserve estimates exceed 800 acres. Between 1400 and 1200 acres have been permitted to the quarry, yet only 500 acres have been mined. Brose estimates these reserves to be approximately 40 million tons of limestone material. Not all of these reserves are readily accessible, but National Lime and Stone does own all the property.

There are no groundwater problems at the quarry. The excess water located in the pit is pumped into settling ponds. Eighty percent of this water is reused.

Dust suppressors are used to control fines on site. The quarry possesses a washing operation for all 57's, 8's, 9's and 70305's and, if required, can wash other sizes as well.

SAMPLING

Bob Stadler of Bowser Morner sampled one drum of coarse aggregate (57's). The coarse aggregate sample was taken from a representative stockpile. See photographs below for view of stockpiles and operations. Materials in the 57 stockpile were light gray,

fossiliferous and coated with a lime dust. Minor amounts of the aggregate contained carbonaceous bands.

SERVICE RECORD

Materials from National Lime and Stone in Carey were approved by the ODOT Laboratory. On site structures using stone from Bucyrus include the truck scales and the processing building (Dout concrete placed the material). The Processing building was constructed in 1940. Although some chipping and slaking is present, Brose noted that damage was caused by abrasion from trucks. Otherwise, the concrete appears to be in fair to good condition. The scale displayed some surface voids, but otherwise appeared to be in good condition.

The quarry supplies materials to Moritz Concrete in Mansfield and Twin Cities Concrete in Cadiz, Ohio.

In regards to previous rejections, Brose noted that he is not aware of any recent rejections; however, approximately 20 years ago National Lime & Stone was the aggregate supplier for the Mansfield Airport. Restrictions were placed on specific areas of quarrying. Since that time, the quarry has supplied material for other airport jobs without restrictions.

CONCLUSIONS

The test results for this material cause concern for durability in regard to freezing and thawing, the high absorption and the high amount of loss during abrasion testing. The material contains little chert compared to other sources tested and is not reactive in regard to alkali silica reactivity testing. Alkali carbonate testing in accordance with ASTM C 1105 should be performed since the material is a carbonate. Additional service record structures should be examined prior to acceptance of this material.

Piedmont Materials Investigation
National Lime & Stone
Bucyrus, Ohio
July 2001

Quarry Name: National Lime & Stone, Bucyrus, Ohio

Phone:419-562-0771 **POC:** Andy Brose, Plant Manager

Location: Take 30W to Bucyrus, take 30 bypass off to right, proceed 6 to 7 miles, turn right onto Bethel Road ~ 2 miles to railroad tracks, hang a left across bridge to office.

Distance from Project: miles

Formation: Possibly Columbus and Delaware Formations. 18 – 20' of Delaware on top of 30' of Columbus.

Lithology: Fossiliferous limestone

Production Rate: 2 million tons/year, 800 tons/hour. Estimate about 40 million tons of reserves.

Transportation Mode: Truck (75%) and Rail (25%), **amount of vehicles available?** Note: hauling distance must be greater than 50 miles in order for rail transportation to be cost effective.

Service Record (preferably COE jobs): Supply to Dout Concrete in Bucyrus
See Photos of Scale at Bucyrus Plant and Processing Building

What ready-mix companies do you supply: Moritz Concrete, Mansfield, Dout Concrete in Bucyrus, Twin Cities Concrete in Cadiz

Any rejections: Over 20 years ago they had restrictions on quarrying for Mansfield Airport. Have done other airport jobs since without restrictions.

Sizes of material which can be provided:

Washing of materials: Wash 57's, 8's, 9's and 70305's

Size of quarry: 1200 to 1400 acres. Only 400 to 500 acres have been quarried.

Years of production/ former names: National Lime & Stone since 1903

Any mapping available, logs of ledges: 1 ledge and 1 bench. Core samples taken in 1988 – logs available at Carey Operation

How many ledges and benches: 1 ledge and 1 bench. 1 active pit and one no longer in use.

What ledges are currently in production: 1 ledge in production. 40' high

From where did Bowser Morner sample: See photo 25 – shows stockpile

Drill pattern and blasting agent. Drill pattern varies, usually a 12X12 pattern. Use AMFO to blast.

Does drill pattern vary per material size

What is blast frequency:

Groundwater problems in pit. Do you use a sump pump: Do some pumping. 80% of water is used/reused. Have settling ponds.

Geology:
Structural features:

Strike and Dip:

Joint spacing & Bedding plane breaks: Bedding planes spaced 2 to 3 feet, planar.

Faults:

Stylolites:

Shale partings: No shale

Carbonaceous lenses:

Dust: Use dust suppressors.

Flaking/slaking:

Presence of Clay: May be ¼" wide clay seam intermittent.

Presence of Chert/Flint: Trace amounts of chert. Passed ODOT specs.

Presence of Pyrite, Mica, Iron etc.

Karstic features:

Comments:
Set Aside stone: ledge rock under bridge exposed since 1950 and ledge rock near current pit exposed since 1997.

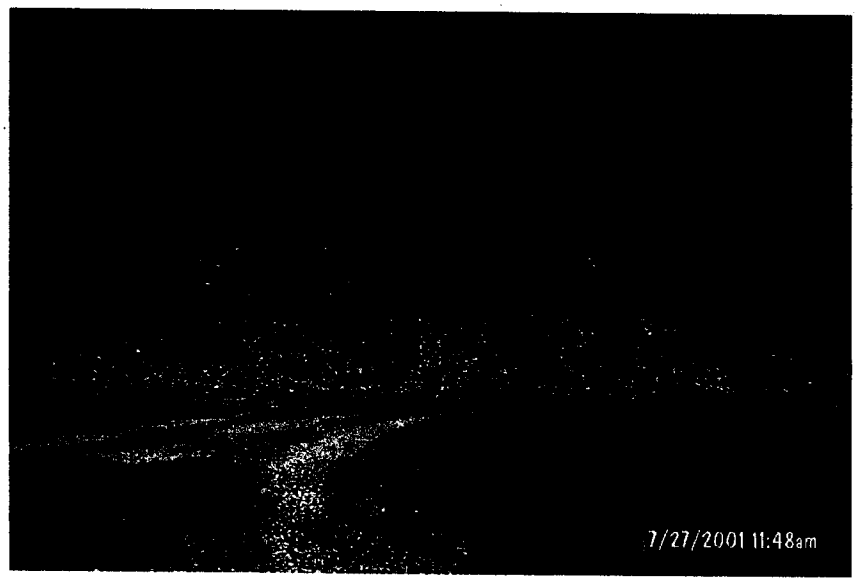

EXHIBIT 2
CONCRETE SOURCE INVESTIGATION
Dover DSA
Twin Cities Concrete Co
Dover, OH

PURPOSE OF INVESTIGATION

Twin Cities Concrete Company was investigated as a possible supplier for concrete for the Dover DSA project.

LOCATION: 3 miles from Dover at 141 Tuscarawas Avenue.

SOURCES

At the time of the investigation, Twin Cities Concrete Co. used the following suppliers for concrete materials:

MATERIAL	TYPE	SOURCE	LOCATION
Fine Aggregate	Limestone	National Lime & Stone	Bucyrus, Ohio
Coarse Aggregate	Limestone Limestone	National Lime & Stone	Bucyrus, Ohio
Sand	Natural Silica Natural River Sand	Oster's	Bolivar
Cement	Type I	Cemex	
Fly Ash	Class F	Samis	
Admixture	Various	Uchlid	Cleveland

Can alternative sources be used to meet project specifications? Yes

Is there a portable batch plant available that may be utilized if necessary? No

MIX WATER SOURCE:
City Water

PRODUCTION RATE:
10 yards per hour

CERTIFICATIONS:

ODOT

SERVICE RECORD:

Note: This service record information contained material from Stockers Sand and Gravel and National Lime and Stone.

Company has been in business since 1948. Have placed concrete at various Muskingum area projects: Atwood boat ramps and walls in 1991, Beach City parapet wall in 1998, Bolivar parapet wall and spillway modification in 1989 (parapet wall in good condition with small cracks near joints and small spalls developing and spillway in good condition with some minor craze cracking noted), Clendenning boat ramp in 1999, Leesville parapet wall in 1985 (noted in PI to be in very good condition), Tappan parapet wall and spillway in 1982 (noted in PI to be in very good condition).

EXHIBIT 3
CONCRETE SOURCE INVESTIGATION
Dover DSA
Stocker Concrete Co
Gnadenhutten, OH

PURPOSE OF INVESTIGATION:

Stocker Concrete Company was investigated as a possible supplier for concrete for the Dover DSA project.

LOCATION: 14.4 miles from Dover.

SOURCES:

At the time of the investigation, Stocker Concrete Co. used the following suppliers for concrete materials:

MATERIAL	TYPE	SOURCE	LOCATION
Fine Aggregate	Limestone	Onsite	
Coarse Aggregate	Limestone Limestone	Onsite	
Sand	Natural Silica Natural River Sand	Onsite	
Cement	Type I	Esrock and Cemex	
Fly Ash	No ash		
Admixture	Various	Grace	Massachusetts

Can alternative sources be used to meet project specifications? Yes

Is there a portable batch plant available that may be utilized if necessary?
Better to use their facility.

MIX WATER SOURCE:
Natural Well

PRODUCTION RATE:
75-125 Yards per hour.

CERTIFICATIONS:
ODOT

SERVICE RECORD:
In business since the 1930's

EXHIBIT 4
CONCRETE SOURCE INVESTIGATION
Dover DSA
24/7 Concrete Co
New Philadelphia, OH

PURPOSE OF INVESTIGATION

24/7 Concrete Company was investigated as a possible supplier for concrete for the Dover DSA project.

Contact Rob Martin 330-432-1011

LOCATION : 7 miles from Dover

SOURCES

At the time of the investigation, 24/7 Concrete Co. used the following suppliers for concrete materials:

MATERIAL	TYPE	SOURCE	LOCATION
Fine Aggregate	Limestone	416 Sand & Gravel	S. New Philadelphia
Coarse Aggregate	Limestone Limestone	416 Sand & Gravel	S. New Philadelphia
Sand	Natural Silica Natural River Sand	416 Sand & Gravel Stockers is alternate	S. New Philadelphia
Cement	Type IA		
Fly Ash	No ash		
Admixture	Various	Uchlid	Cleveland

Can alternative sources be used to meet project specifications? Yes

Is there a portable batch plant available that may be utilized if necessary?
No, they use volumetric mixers on site

MIX WATER SOURCE:
Well

PRODUCTION RATE:
One mixer is 30 yards per hour the other is 60 yards per hour

CERTIFICATIONS:

Have to get them from the office

SERVICE RECORD:

In business for 5 years.

EXHIBIT 5
CONCRETE SOURCE INVESTIGATION
Dover DSA
Pleasant Valley Ready Mix Co
Sugarcreek, OH

PURPOSE OF INVESTIGATION

Pleasant Valley Ready Mix Company was investigated as a possible supplier for concrete for the Dover DSA project.

LOCATION : 12 miles from Dover at 559 Pleasant Valley Road North

SOURCES:

At the time of the investigation, Pleasant Valley used the following suppliers for concrete materials:

MATERIAL	TYPE	SOURCE	LOCATION
Fine Aggregate	Limestone	Nat. Lime & Stone	Wooster and Bucyrus
Coarse Aggregate	Limestone Limestone	National Lime & Stone	Wooster and Bucyrus
Sand	Natural Silica Natural River Sand	Shady Bend	Newcomerstown, OH ODOT CERT
Cement	I	Cemex	Wampum Plant
Fly Ash	Type 6A material	Headwater Resources	Sammis plant
Admixture	Various	Uchlid Chemical Waco Supply	Cleveland

Can alternative sources be used to meet project specifications? "Probably"

Is there a portable batch plant available that may be utilized if necessary? Yes

MIX WATER SOURCE:
Natural Well

PRODUCTION RATE:
100 yards per hour

CERTIFICATIONS:
ODOT

SERVICE RECORD:
1989 started business